1. (Amended) A slurry used in a chemical mechanical polishing (CMP) process on a ruthenium thin film or a ruthenium alloy thin film, the slurry comprising:

an oxidant consisting essentially of ceric ammonium nitrate [$(NH_4)_2Ce(NO_3)_6$]

an abrasive consisting essentially of inorganic particles.

2. (Amended) The slurry according to claim 1 further comprising an acid.

3. (Amended) The slurry according to claim 1, wherein the ceric ammonium nitrate is present in an amount ranging from about 1 to about 10% by weight of the slurry.

6. (Amended) The slurry according to claim 2, wherein the inorganic particles of the abrasive are selected from the group consisting of CeO_2 particles, ZrO_2 particles, Al_2O_3 particles and mixtures thereof.

7. (Amended) The slurry according to claim 1, wherein a grain size of the abrasive is less than 1 μm.

8. (Amended) The slurry according to claim 1, wherein the abrasive is used in an amount ranging from about 1 to about 5% by weight of the slurry.

REMARKS

This paper is filed in response to the office action mailed on October 22, 2002.

In the office action, the restriction requirement between claims 1-13 and 14-23 is made final. In response, claims 14-23 have been canceled.

The office action also rejects claims 1-8 and 11-13 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,375,545 ("Yano"). In response, claim 1 has been amended to traverse this rejection. Specifically, claim 1 recites a CMP slurry for ruthenium and ruthenium alloy thin films that includes an oxidant consisting essentially of ceric ammonium nitrate and an abrasive consisting of inorganic particles.

In contrast, Yano is directed toward a CMP slurry that includes polymer particles as the abrasive. While Yano does suggest that other abrasives may be

included in its formulation, nowhere in Yano does it teach or suggest the use of the inorganic abrasive particles recited in claim 1 as the sole source of the abrasive. Further, nowhere in Yano does it teach or suggest the use ceric ammonium nitrate as the sole source of the oxidant.

Further, the claimed CMP slurry is applied to a RTN thin film which forms a barrier film. On the other hand, the Yano CMP slurry is designed for metal lines such as tungsten films, aluminum films and so on. Yano does not teach that its CMP slurry can be used on RTN thin films. See Yano at col. 4, lines 61-67.

Further, the Yano patent uses organic particles with a cross-linked structure, that is a polymer and a base abrasive. Though it discloses that inorganic particles such as cerium oxide, zirconium oxide and aluminum oxide can be used with the polymer particles, Yano does not teach or suggest the use of inorganic particles as the primary abrasive.

Accordingly, claim 1, as presently amended, is not anticipated by or obvious in view of Yano and therefore the rejection of claims 1-8 and 11-13 under 35 U.S.C. § 102(e) as being anticipated by Yano is improper and should be withdrawn.

The office action also rejects claims 9 and 10 under 35 U.S.C. § 103 as being unpatentable over Yano in view of U.S. Patent No. 5,804,513 ("Sakatani"). In response, applicants present the following remarks.

Specifically, Yano does not teach or suggest a CMP slurry for ruthenium or ruthenium alloy films where ceric ammonium nitrate is the sole oxidant and the sole source of abrasive includes particles selected from the group consisting of ceric oxide, zirconium oxide, aluminum oxide and mixtures thereof. Because Sakatani is only cited for the proposition that it teaches a low pH, Sakatani cannot be combined with Yano in an obviousness rejection of claim 1. Because claim 1 is allowable over any hypothetical combination of these two references, applicants respectfully submit that claims 2-5 and 7-13 are allowable as well.

Accordingly, applicants respectfully submit that the rejection of claims 9-10 under 35 U.S.C. § 103(a) as being unpatentable over Yano in view of Sakatani is improper and should be withdrawn.

Applicants respectfully submit that this application is now in a condition for allowance and an early action so indicating is respectfully requested.

The Commissioner is authorized to charge any fee deficiency required by this paper, or credit any overpayment, to Deposit Account No. 13-2855.

Respectfully submitted,

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January 21, 2003 By: _____

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VERSION WITH MARKINGS TO SHOW CHANGES

In the Specification:

The paragraph beginning on page 6, line 8 has been replaced with the following rewritten paragraph:

--In more detail, the slurry containing about 2 wt% of HNO_3 and about 2 wt% of ceric ammonium nitrate has a polishing rate of about 600 Å/min under a polishing pressure of 1 psi; the slurry containing about 2 wt% of HNO_3 and about 6 wt% of ceric ammonium nitrate has a polishing rate of about 1200 Å/min under a polishing pressure of 1 psi; the slurry containing about 2 wt% of HNO_3 and about 10 wt% of ceric ammonium nitrate has a polishing rate of about 1400 Å/min under a polishing pressure of 1 psi; the slurry containing about 6 wt% of HNO_3 and about 2 wt% of ceric ammonium nitrate has a polishing rate of about 1050 Å/min under a polishing pressure of 1 psi; and the slurry containing about 10 wt% of HNO_3 and about 2 wt% of ceric ammonium nitrate has a polishing rate of about 1200 Å/min under a polishing pressure of 1 psi.--

The paragraph beginning on page 6, line 19 has been replaced with the following rewritten paragraph:

--The slurry containing about 2 wt% of HNO_3 and about 2 wt% of ceric ammonium nitrate has a polishing rate of about 1000 Å/min under a polishing pressure of 4 psi, the disclosed slurry obtains a polishing rate over 1000 Å/min even under a polishing pressure of 1 psi, by slightly increasing a content of HNO_3 and ceric ammonium nitrate.--

The paragraph beginning on page 11, line 19 has been replaced with the following rewritten paragraph:

--A table revolution number and a wafer revolution number were respectively set up to be 20 rpm and 80 rpm, by using a rotary type system. Here, the CMP process was performed on the ruthenium film under a polishing pressure of 1 psi by using the slurry prepared in Example 1 (polishing rate is about 600 Å/min).--

The paragraph beginning on page 12, line 4 has been replaced with the following rewritten paragraph:

--The procedure of Example 6 was repeated but using the slurry prepared in Example 2, instead of using the slurry prepared in Example 1 (polishing rate is about 1200 Å/min).--

The paragraph beginning on page 12, line 8 has been replaced with the following rewritten paragraph:

--The procedure of Example 6 was repeated but using the slurry prepared in Example 3, instead of using the slurry prepared in Example 1 (polishing rate is about 1400 Å/min).--

The paragraph beginning on page 12, line 10 has been replaced with the following rewritten paragraph:

--The procedure of Example 6 was repeated but using the slurry prepared in Example 4, instead of using the slurry prepared in Example 1 (polishing rate is about 1050 Å/min).--

The paragraph beginning on page 12, line 13 has been replaced with the following rewritten paragraph:

--The procedure of Example 6 was repeated but using the slurry prepared in Example 5, instead of using the slurry prepared in Example 1 (polishing rate is about 1200 Å/min).--

The paragraph beginning on page 12, line 18 has been replaced with the following rewritten paragraph:

--A table movement speed and a wafer revolution number were respectively set up to be 500 fpm and 20 rpm, by using a linear type system. Here, the CMP process was performed on the ruthenium film under a polishing pressure of 1.5 psi by using the slurry prepared in Example 1 (polishing rate is about 1000 Å/min).--

The paragraph beginning on page 12, line 23 has been replaced with the following rewritten paragraph:

--A table revolution number and a wafer revolution number were respectively set up to be 20 rpm and 80 rpm, by using a rotary type system. Here, the CMP process was performed on the ruthenium film under a polishing pressure of 4 psi by using a slurry for tungsten (SSW2000 slurry of CABOT) (polishing rate is about 10 Å/min).--

The paragraph beginning on page 13, line 8 has been replaced with the following rewritten paragraph:

--A table revolution number and a wafer revolution number were respectively set up to be 20 rpm and 80 rpm, by using a rotary type system. Here, the CMP process was performed on the ruthenium film under a polishing pressure of 4 psi by using a slurry for aluminum (EPA5680 slurry of CABOT) (polishing rate is about 300 Å/min).--

In the Claims:

Claims 14-23 have been canceled without prejudice or disclaimer.

Claims 1-3 and 6-8 have been amended, as follows:

1. (Amended) A slurry used in a chemical mechanical polishing (CMP) process on a ruthenium thin film or a ruthenium alloy thin film, the slurry comprising:

an oxidant consisting essentially of ceric ammonium nitrate $[(NH_4)_2Ce(NO_3)_6]$

an abrasive consisting essentially of inorganic particles.

2. (Amended) The slurry according to claim 1 further comprising [an abrasive and] an acid.

3. (Amended) The slurry according to claim [2] 1, wherein the ceric ammonium nitrate is present in an amount ranging from about 1 to about 10% by weight of the slurry.

6. (Amended) The slurry according to claim 2, wherein the inorganic particles of the abrasive [is] are selected from the group consisting of CeO_2 particles, ZrO_2 particles, Al_2O_3 particles and mixtures thereof.

7. (Amended) The slurry according to claim [2] 1, wherein a grain size of the abrasive is less than 1 μm.

8. (Amended) The slurry according to claim [2] 1, wherein the abrasive is used in an amount ranging from about 1 to about 5% by weight of the slurry.